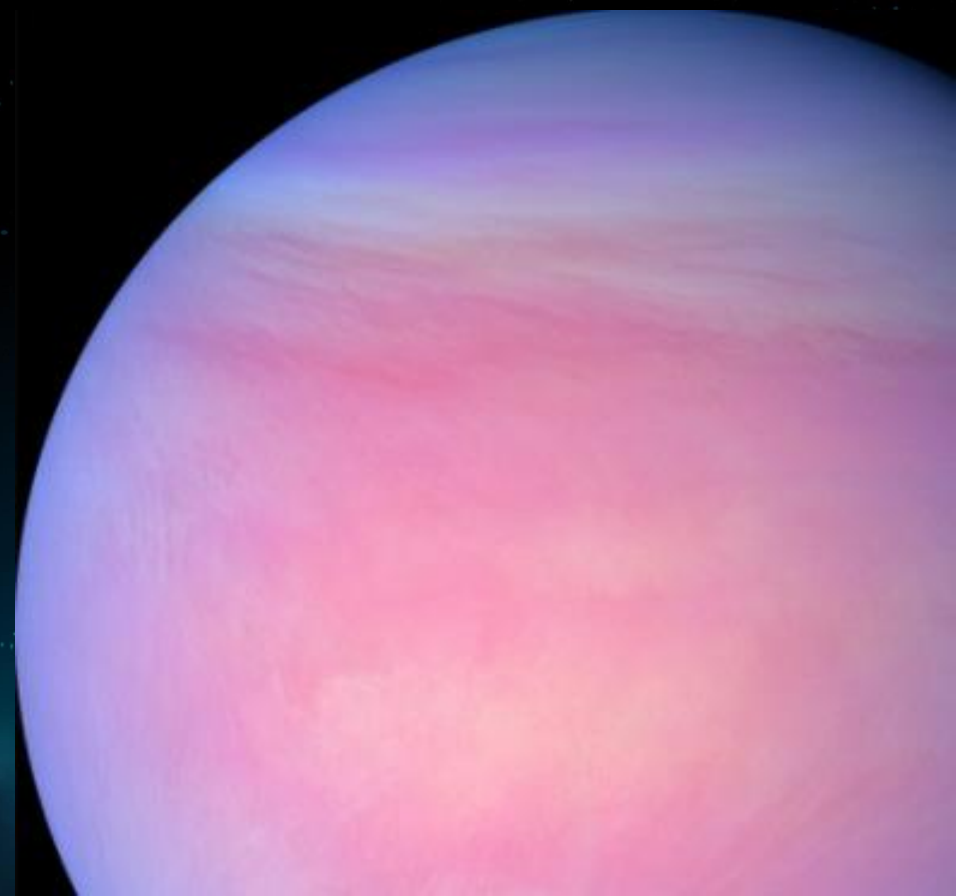
Tibor Kremic (Presenting), NASA Glenn

Seismic and Atmospheric Insitu Science Mission



Outline

- Motivation and Challenges
- Long-Duration Lander Characteristics
- Status of System / Capability
- Next Steps

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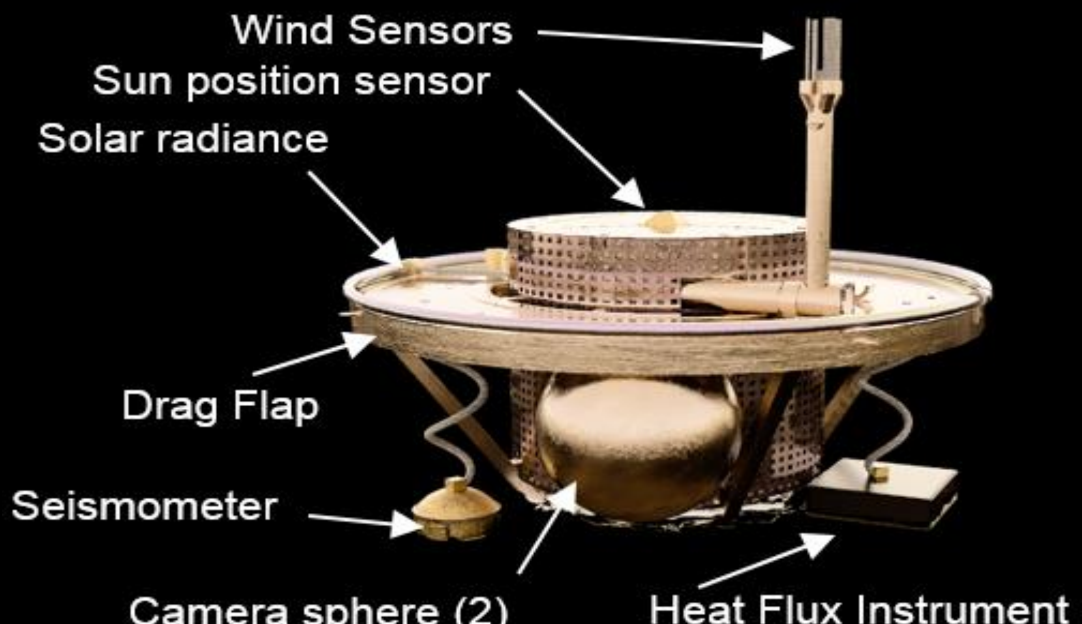

Science Objectives

- We know why Venus is a compelling object of scientific interest

- SAEVe's unique strengths are acquiring ***In situ temporal data***
  - Venus seismicity, lithosphere structure and bulk composition
  - Meteorology, Chemistry variability

- SAEVe also contributes to rock and soil distribution and morphology, estimating momentum exchange, surface energy balance

2 Landers

Science Objectives Tackled

1) Determine if Venus is seismically active and characterize the rate and style of activity,
2) Determine crust and lithosphere thickness and composition
3) Acquire temporal meteorological data to guide global circulation models
4) Estimate the momentum exchange between the planet and its atmosphere
5) Measure atmospheric chemistry variability
6) Determine current rate of heat loss from the Venus interior
7) Examine rock and soil distribution and morphology

One Lander

Science Objectives Tackled

1) Determine if Venus is seismically active and characterize the rate and style of activity,
2) Acquire temporal meteorological data to guide global circulation models
3) Estimate the momentum exchange between the planet and its atmosphere
4) Measure atmospheric chemistry variability
5) Determine current rate of heat loss from the Venus interior
6) Examine rock and soil distribution and morphology

De-Scoped Lander

Science Objectives Tackled

1) Determine if Venus is seismically active and characterize the rate and style of activity,
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SAEVe Science Ladder

Entry challenges due to location and atmosphere of Venus

The Technical Challenges of Venus Surface Science

Altitude	Temperature
80 km	-93° C
70km	-43° C
60km	-23° C
50 km	67° C
40 km	142° C
30 km	210° C
20 km	390° C
10 km	410° C
0 km Surface	455° C

Layers of think Sulfuric Acid clouds limit remote sensing below clouds

Little solar energy reaches surface

Temperatures over 450°C

Power at the surface is a big challenge for missions

High Pressure – CO_2 laden atmosphere

Extreme temperatures kill lander electronics and systems.

Reactive Chemistry

Crushing pressure

Essentially no magnetic field

Lander Characteristics

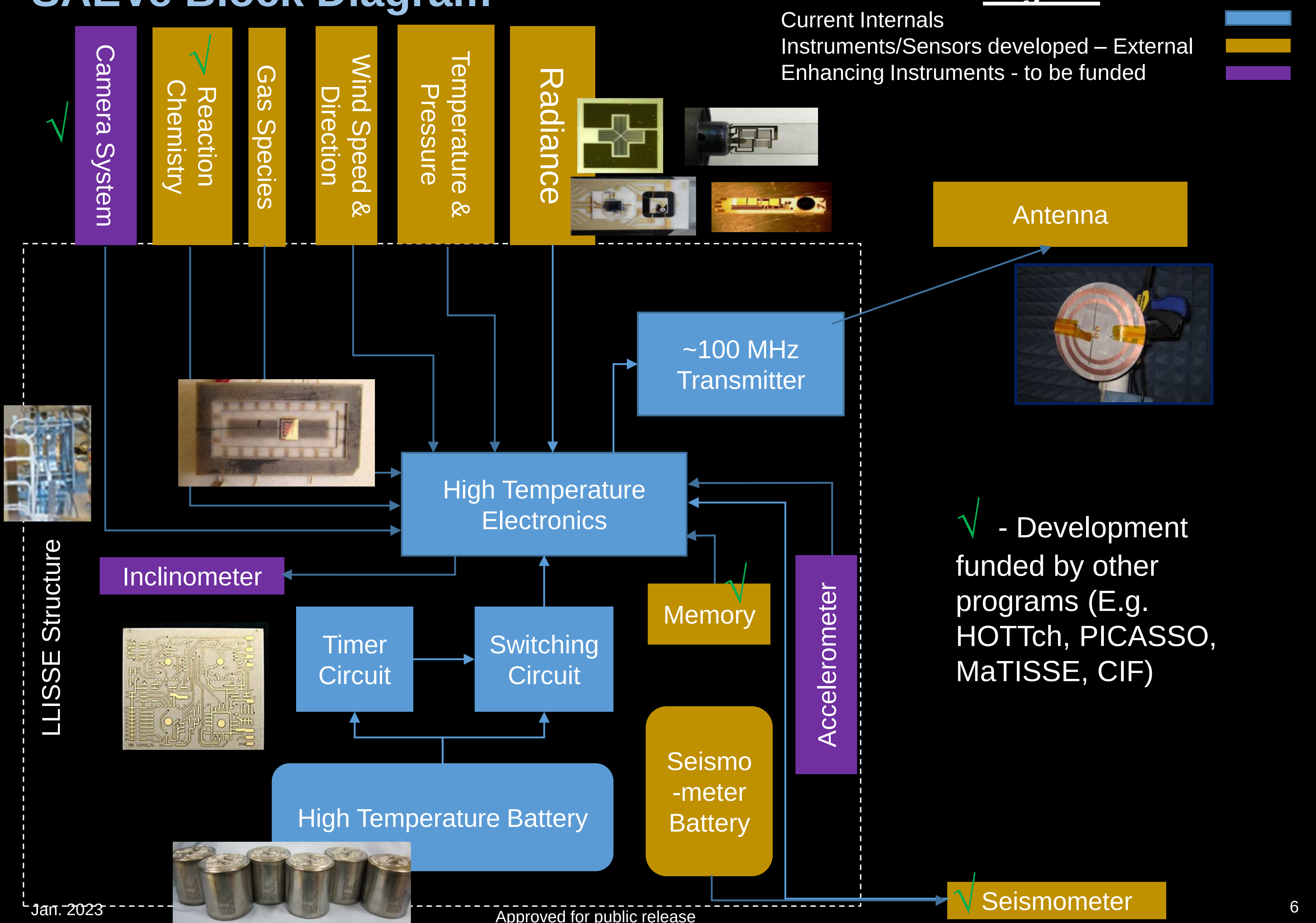
- Technology advances are enabling operation of a small lander for 120 days or longer
  - SAEVe is based on capabilities developed by the LLISSE project

- Our approach is to design all lander components* and subsystems to operate in the harsh Venus surface environment (T, P, Chemistry, Radiance, Seismicity).

  *Imaging is short duration activity at start of mission.

- Lander is < 25 kg, operates for 120 days or more, and ~50cm at widest point

SAEVe Block Diagram

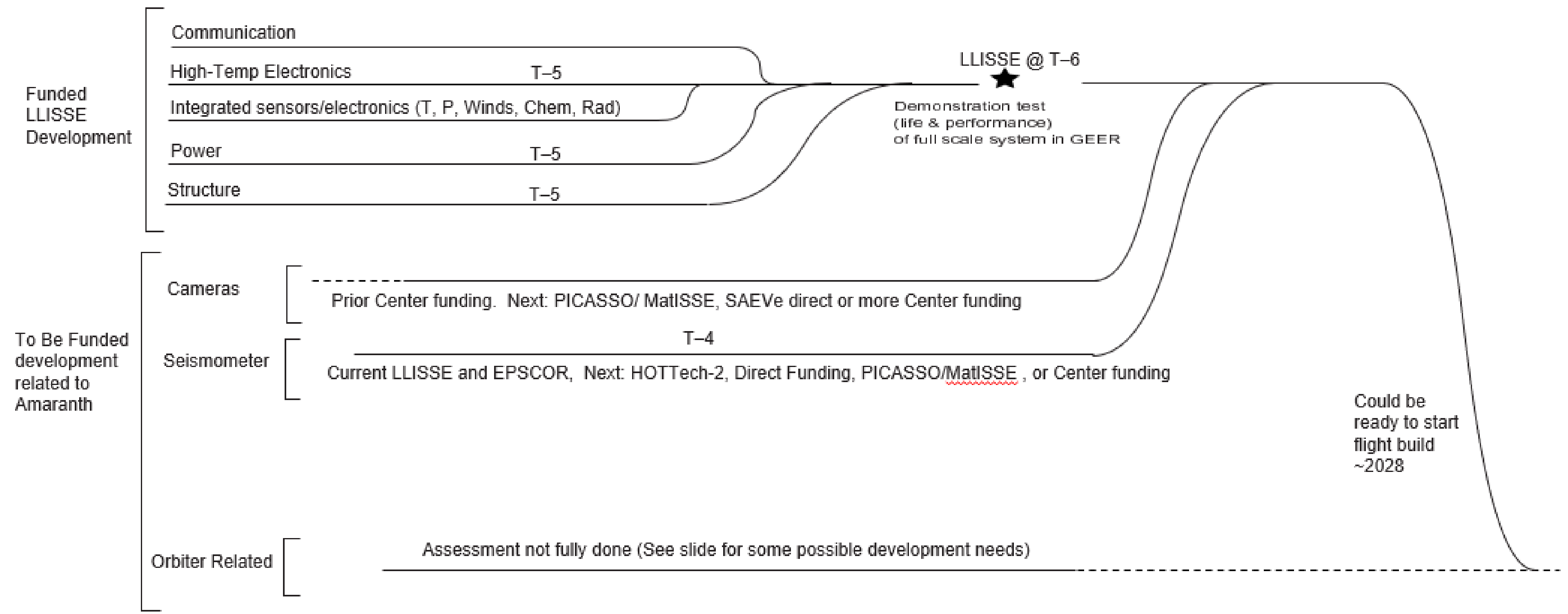


Top Level Status

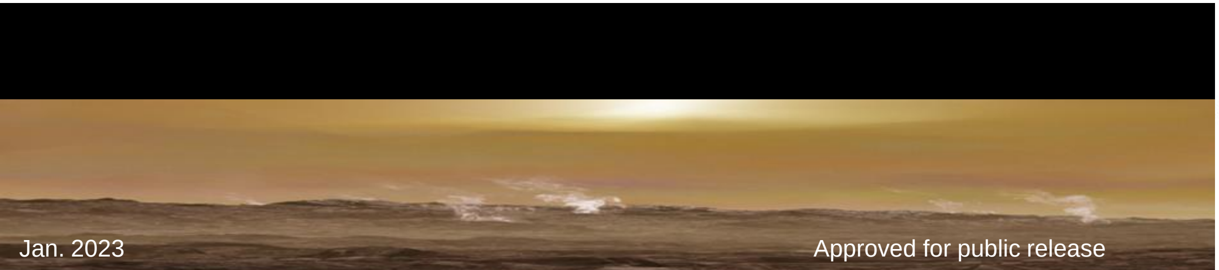
- LLISSE has made tremendous progress on the capability to operate on the Venus surface
- SAEVe uses LLISSE subsystems and adds instruments and larger battery
- Status:
  - Robust high-temperature processing electronics, fabrication in process
  - High-temperature batteries
    - Full voltage battery tested at temp. and under simulated loads ~120 day life
    - Transitioned efforts toward packaging
  - Antenna material verification in process (just completing test in GEER)
  - Critical comm components in fabrication, will be assessed & fed back into design
  - High-temperature instruments & sensors
    - Varying readiness level – TRL 3 – 5+. Most at TRL4 or >
    - Seismometer in development under HOTTech-2
  - Operation of most sensors and core electronics in simulated Venus environment have been demonstrated several times

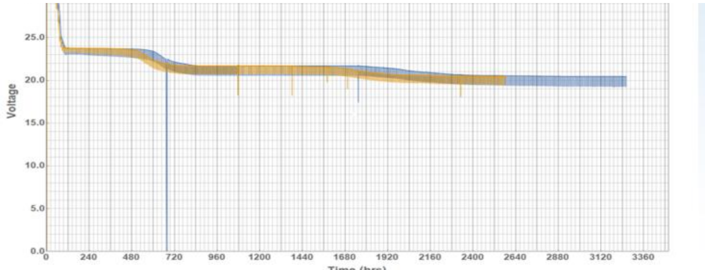
  - HEEET TPS assessed to deliver SAEVe to surface (HEEET at TRL-6 for Venus)

Development Flow



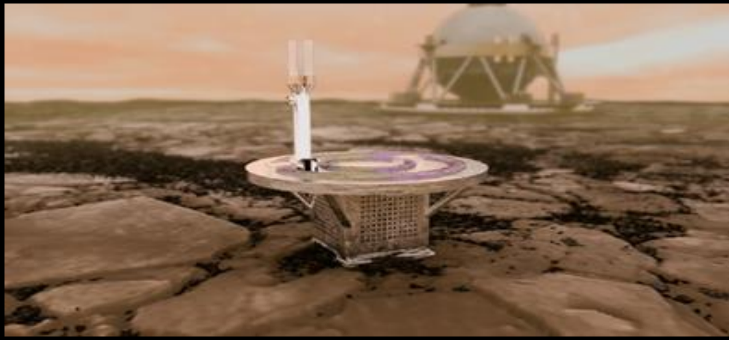
Legend:	DG–X	Decision gate	G –	GEER test (1 test can support multiple components)
	T–X	Expected TRL level	(Date) –	Year TRL is estimated to be achieved



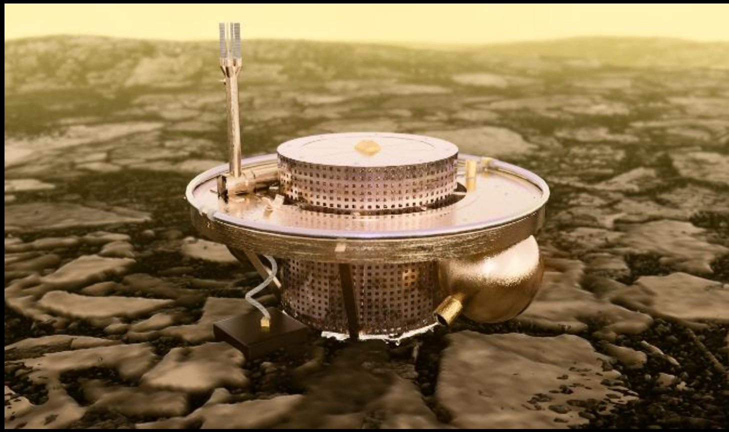


Next-Steps / Take-aways

- Continue maturing technology and engage potential mission partners
  - Could support a mission late in 2020's, with resource availability
- Hardware exists for sub-systems and various levels of testing have been completed
- Major SAEVe instrument, the seismometer, also in development under HOTTech-2, low power memory as well



LLISSE Lander



SAEVe Concept

Questions?